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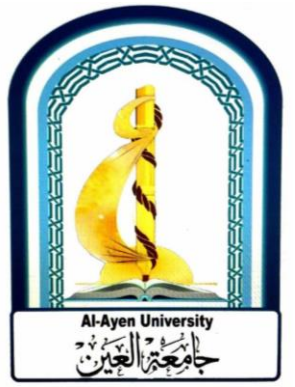


# Mechanics

**Dr. Mohaimen Al-Thamir**

**Title: Vectors; Graphical solution**

**Lec. Number: 1**

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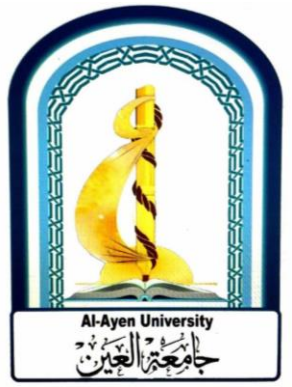


Mechanics is the physical science which deals with the effects of forces on objects. The subject of mechanics is logically divided into two parts: statics, which concerns the equilibrium of bodies under action of forces, and dynamics, which concerns the motion of bodies.

References:

ENGINEERING MECHANICS STATICS
J. L. MERIAM • L. G. KRAIGE • J. N. BOLTON

ENGINEERING MECHANICS DYNAMICS
J. L. MERIAM • L. G. KRAIGE • J. N. BOLTON

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# Basic concepts

Space/ is the geometric region occupied by bodies whose positions are described by linear and angular measurements relative to a coordinate system. For three-dimensional problems, three independent coordinates are needed. For two-dimensional problems, only two coordinates are required.

Time/ is the measure of the succession of events and is a basic quantity in dynamics. Time is not directly involved in the analysis of statics problems.

Mass/ is a measure of the inertia of a body, which is its resistance to a change of velocity. Mass can also be thought of as the quantity of matter in a body. The mass of a body affects the gravitational attraction force between it and other bodies.

Force/ is the action of one body on another. A force tends to move a body in the direction of its action. The action of a force is characterized by its magnitude, by the direction of its action, and by its point of application. Thus force is a vector quantity.

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# Basic concepts

A particle/ is a body of negligible dimensions. In the mathematical sense, a particle is a body whose dimensions are considered to be near zero so that we may analyze it as a mass concentrated at a point. We often choose a particle as a differential element of a body. We may treat a body as a particle when its dimensions are irrelevant to the description of its position or the action of forces applied to it.

Rigid body/ A body is considered rigid when the change in distance between any two of its points is negligible for the purpose at hand. For instance, the calculation of the tension in the cable which supports the boom of a mobile crane under load is essentially unaffected by the small internal deformations in the structural members of the boom.

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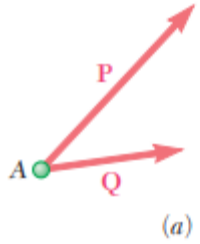
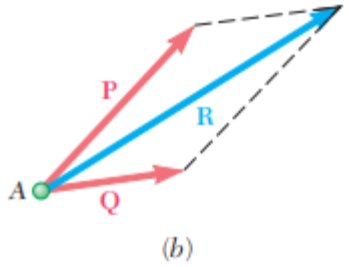
# vectors

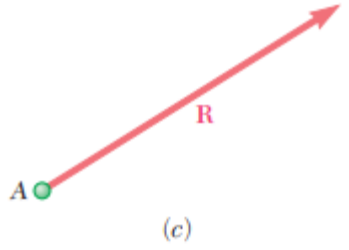
Two vectors: P & Q



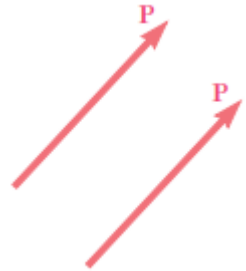

Two vectors and their resultant: P & Q, R




The diagonal that passes through A represents the resultant.




Equal vectors




Two vectors which have the same magnitude and the same direction are said to be equal

Positive and negative vectors


The negative vector of a given vector P is defined as a vector having the same magnitude as P and a direction opposite to that of P

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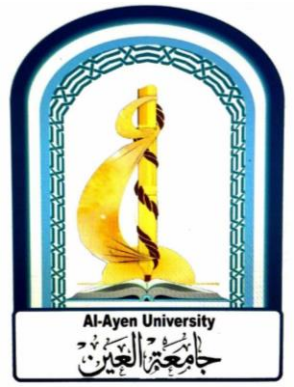
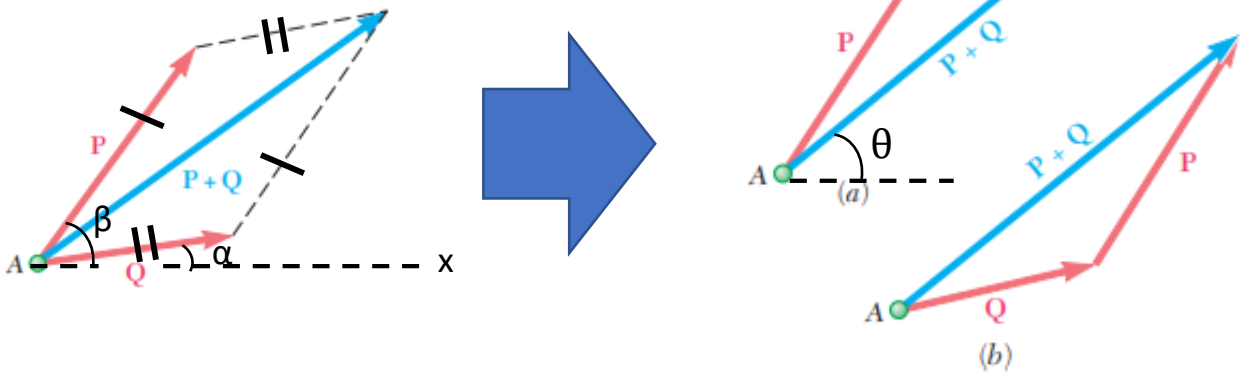



# Vectors addition and subtraction: Graphical Solution

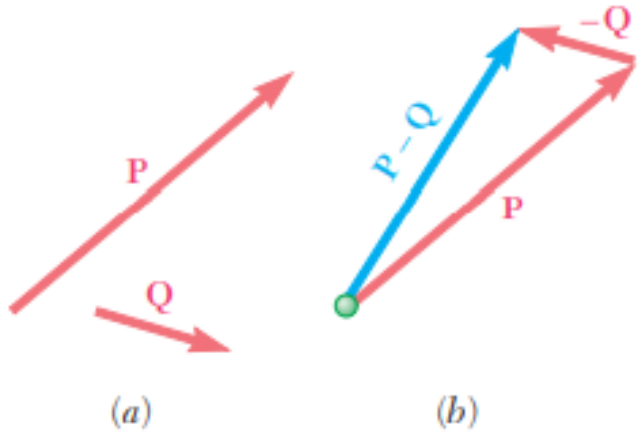
## Two vectors addition




$$\mathbf{P} + \mathbf{Q} = \mathbf{Q} + \mathbf{P}$$

Vectors add according to the parallelogram law. Thus, the sum of two vectors P and Q is obtained by attaching the two vectors to the same point A and constructing a parallelogram, using P and Q as two sides of the parallelogram.

## Two vectors subtraction




The subtraction of a vector is defined as the addition of the corresponding negative vector

$$\mathbf{P} - \mathbf{Q} = \mathbf{P} + (-\mathbf{Q})$$

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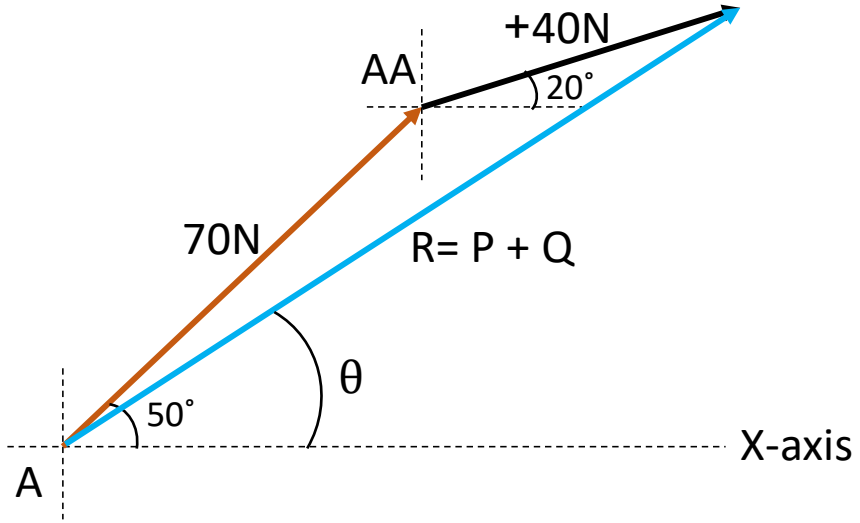
## امثلة توضيحية لكيفية جمع او طرح المتجهات باستخدام طريقة الرسم

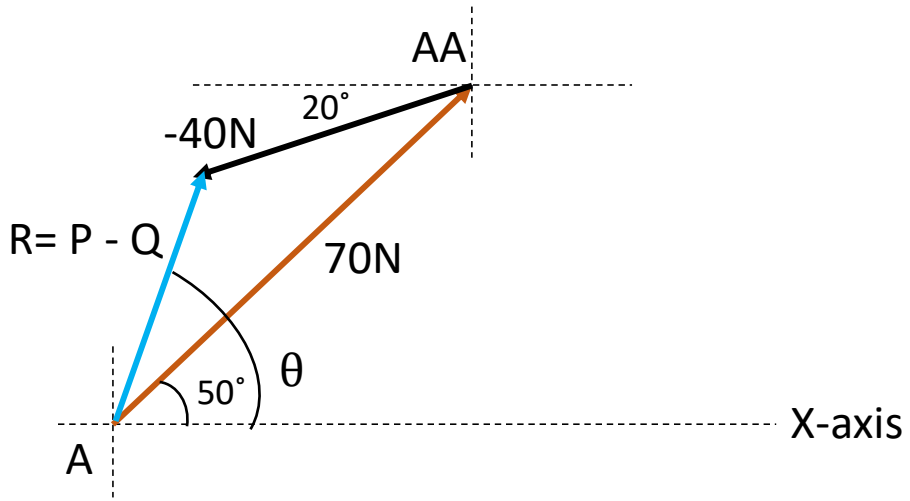
P = +70 N, angle with x –axis = 50˚

Q = +40 N, angle with x –axis = 20˚




P = +70 N, angle with x –axis = 50˚

Q = - 40 N, angle with x –axis = 20˚




**Homework:**

P = -70 N, angle with x –axis = 50˚

Q = + 40 N, angle with x –axis = 20˚

Find the resultant (R) and its direction (θ)

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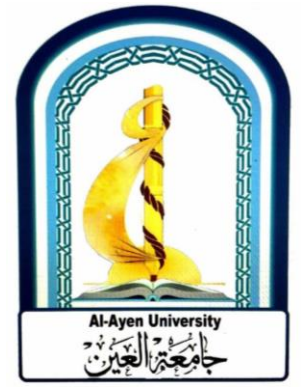
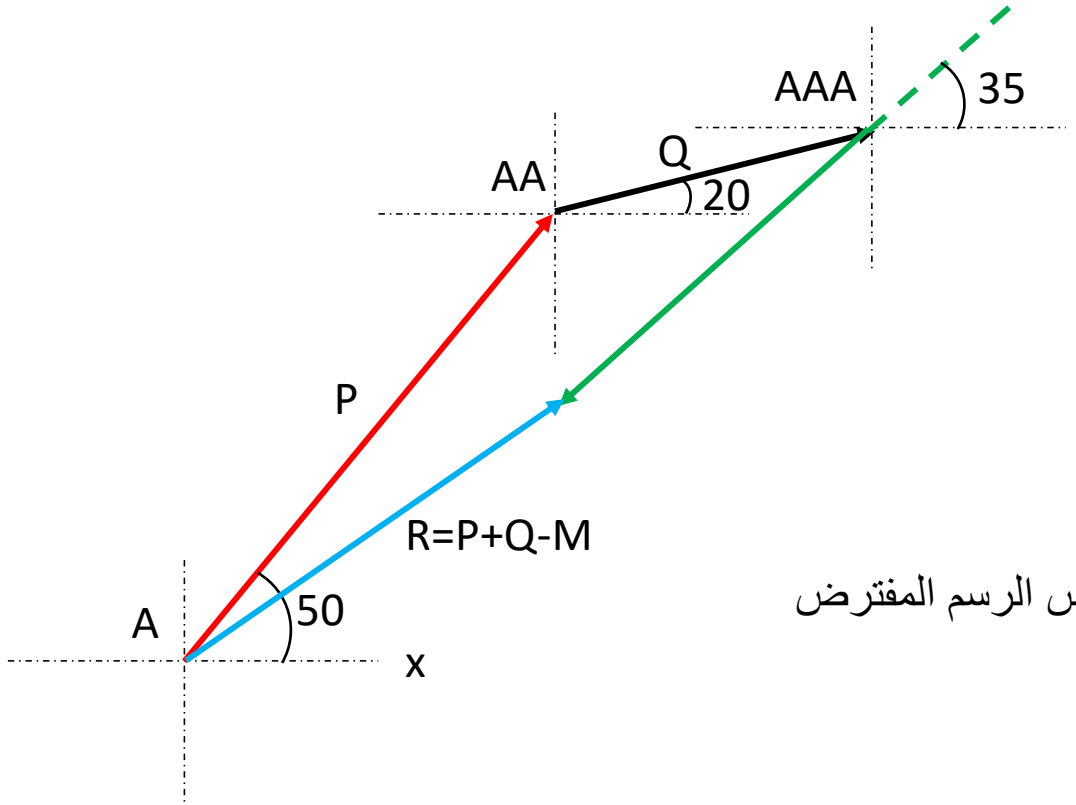



## امثلة توضيحية لكيفية جمع او طرح المتجهات باستخدام طريقة الرسم

P = 70 N, angle with x –axis = 50˚

Q = 40 N, angle with x –axis = 20˚

M = -50 N, angle with x –axis = 35˚




خطوات الحل:

1- نفرض مقياس رسم مناسب
2- تحديد نقط الأصل A
3- نرسم P
4 – نحدد نقطة اصل جديدة AA
5- نرسم Q
6- نحدد نقطة اصل أخرى جديدة AAA
7- نرسم M
8- ننطلق من نقطة الأصل الأولى (A) باتجاه نهاية المتجة الأخير
9- نقيس المحصلة باستخدام المسطرة ثم نحسب قيمتها حسب مقياس الرسم المفترض
10– نحسب قيمة الزاوية باستخدام المنقلة